



David J. McGoff  
Acting Deputy Director, Office of Nuclear Energy

**ÖZET**

A.B.D.'nde 1992 yılında üretilen elektrik enerjisinin yüzde 56'sı kömürden sağlanmıştır. Nükleer enerji, yüzde 22 ile, üretime katkı sağlayan ikinci büyük enerji kaynağıdır. Doğal gazın toplam enerji üretimindeki katkısı yüzde 9 iken, hidro-elektrik ve yenilenebilir enerji kaynaklarından sağlanan enerji yüzde 9 oranındadır. Halihazırda, 109 nükleer güç santralının toplam 99.000 MWe üretim kapasitesi bulunmaktadır. Nükleer güç santrallarından geçen 30 yılda elde edilen deneyim birikimi, verimliliği, güvenliği ve performansı geliştirmek için, yeni nesil santralların tasarım kriterlerinin oluşmasında katkı oluşturmaktadır. Yeni İleri Hafif Sulu Reaktörler, inşaa ve bakım maliyetlerini düşürecek basitleştirilmiş tasarım özelliklerini taşıyacaklardır. Güvenliği artırmak için, bu reaktörlerin, tasarım marjları genişletilmekte ve tasarımda insan faktörü gözönüne alınmaktadır.

**ABSTRACT**

In the United States, coal provided 56 percent of the electricity generated in 1992. Nuclear energy was the next largest contributor, supplying 22 percent. Natural gas provided 9 percent, while hydro-electric and renewables together supplied another 9 percent. Currently, the 109 nuclear power plants in the U.S. have an overall generating capacity of 99,000 MWe. To improve efficiency, safety, and performance, the lessons of 30 years of experience with nuclear powerplants are being incorporated into design criteria for the next generation of U.S. plants. The new Advanced Light Water Reactor plants will feature simpler designs, which will enable more cost-effective construction and maintenance. To enhance safety, design margins are being increased, and human factors are being considered and incorporated into the designs.

Before I begin, I want to express my appreciation to the organizers of this Forum. It's privilege to be here with you today at this important conference on the prospects for nuclear powerplants in Turkey.

Nuclear power in the United States, and indeed the world, is moving in new and interesting directions as we approach the 21st century. We are asking ourselves very serious questions about the composition of our future energy mix--questions such as how much electric capacity will we need in the next century? What is the optimum mix among coal, nuclear, gas, renewable and conservation to meet this need? And of course, the ultimate question: what strategy will best lead us to success in attaining our economic and energy goals?

I will be covering today several significant topics which play a crucial role in determining the role of new nuclear powerplants in the United States during the 1990s. In the U.S., utilities will make the ultimate decision on which type of powerplant to build to meet new electricity demand. How well current nuclear powerplants operate is a key factor in the decision-making process affecting new plant orders. Quiet, steady improvement in the operation of the majority of U.S. plants is becoming a success story.

The current U.S. strategy for the future is to ensure that the nuclear option remains open. For this reason, the Administration supports an Advanced Light Water Reactor Program to enable new nuclear powerplant orders in the 1990s. The Administration largely bases its support for nuclear power on a philosophy that gives priority to near-term technologies that can economically compete in the marketplace.

Obviously then, ensuring the competitive economics of nuclear power is of vital importance to enabling new plant orders in this decade. Thirty years of operating nuclear powerplants in the United States have taught us not only how to improve plant performance, but also how to construct and operate our plants more economically.

I will also be explaining how recent licensing legislation and progress in waste management is providing further support to maintaining the nuclear power option and improving nuclear power economics. Finally, I will be briefly discussing the U.S. Actinide recycle Program and the potential benefits this technology offers to solving the waste management problem.

Let's begin with a quick overview of world nuclear use and the operation of current nuclear powerplants.

As of April 1993, 424 nuclear powerplants were operating in 30 countries, providing a generating capacity of over 330 GWe, or an average of 22 percent of the total electricity generated in countries with nuclear power. In total, nuclear power supplied about 17 percent of the world's electricity in 1993.

The Energy Information Administration projects that world nuclear capacity will increase from 330 GWe in 1992 to between 369 and 459 GWe in 2010. France currently has 5 nuclear units under construction. In addition to Japan's 44 operating nuclear power plants, which provided 28 percent of its electricity in 1992, it has nine new units under construction. South Korea, which experiences a 15 percent annual increase in electricity demand, operates nine nuclear powerplants which produced 43 percent of its total electricity in 1992. Other Pacific-Rim countries, such as Taiwan, are also moving forward with ambitious nuclear programs.

In the United States, coal provided 56 percent of the electricity generated in 1992. Nuclear energy was the next largest contributor, supplying 22 percent. Natural gas provided 9 percent, while hydro-electric and renewables together supplied another 9 percent. Oil was last in size of contribution, providing only three percent. This relatively small contribution provided by oil is largely a result of the addition of several nuclear powerplants to the U.S. production grid during the last two decades.

Currently, the 109 operable nuclear powerplants in the United States have an overall generating capacity of 99,000 MWe. Eight states depend on nuclear power for more than 40 percent of their electricity, and an additional 11 states depend on nuclear power for at least 25 percent of their electricity.

In addition to being a major contributor to the electricity supply of the United States, nuclear power also contributes to meeting environmental goals such as reducing utility sector emissions of regulated atmospheric pollutants.

Electricity production accounts for 66 percent of sulfur dioxide emissions and 35 percent of nitrogen oxide emissions in the U.S. Both of these gases are believed to be associated with acid rain. But nuclear power and hydropower are the only two major commercially available sources of electricity generation that do not emit sulfur dioxide and nitrogen oxide.

There is significant scientific concern about the impacts of so-called "greenhouse gases", such as carbon dioxide, carbon monoxide, methane, chlorofluorocarbons, and nitrogen oxide. About 57 percent of all greenhouse gases being added to the atmosphere are derived from energy use and production. Nuclear powerplants do not produce "greenhouse gas" as a byproduct of electricity production.

If the current generation of nuclear powerplants were not on line, U.S. electric utility emissions of nitrogen oxide, carbon dioxide, and sulfur dioxide would be approximately 30 percent higher. By substituting nuclear for fossil fuels, the U.S. reduces utility emissions of nitrogen oxide alone by 2 million tons and carbon dioxide emissions by 420 million tons annually. To place this in context, the 420 million metric tons of carbon dioxide avoided each year by using nuclear power represents 100 percent of the U.S. target for carbon dioxide emission reduction by 2000.

Lessons learned from over 30 years of operating experience with nuclear powerplants in the U.S. are helping us improve the performance, safety, and efficiency of our current plants. Over the past 10 years, the performance of U.S. nuclear units has improved significantly. Capacity factors increased from 56 to 70 percent and the number of unplanned automatic scrams for each 7000 hours critical decreased by a factor of six.

Several U.S. nuclear plants now rank among the most productive in the world. Examples include General Electric Company's Monticello plant in Minnesota, Westinghouse's Vogtle plant in Georgia, Asea, Brown, Boveri-Combustion Engineering's St. Lucie plant in Florida. In 1992, 10 U.S. units were among the top 15 nuclear plants in the world with the highest capacity factors.

During this same 10-year period, the gross heat rate for U.S. plants decreased, resulting in improved thermal performance, and collective radiation exposures for boiling water reactor and pressurized water reactor plants also decreased substantially.

Similar improvement was charted in the industrial safety accident rate, and the volume of low-level solid radioactive waste for boiling water and pressurized water reactor plants decreased by a factor of four. Based on these performance indicators, it is clear that the majority of U.S. plants are meeting their economic and performance goals and are being "going neighbors."

A few U.S. plants have been shut down before the end of their planned lifetime. These shutdowns have been due to local factors, however, such as abundant sources of cheap natural gas. These few shutdowns are not surprising in a population of over one hundred plants, however; we in the United States are very pleased with the overall performance of our nuclear powerplants.

Now I want to turn your attention to the U.S. strategy for meeting future electricity demand. This strategy reflects the close tie between electricity supply and economic growth in the United States.

In developing such a strategy, it is useful to understand the total U.S. electricity picture. After the oil shocks of the 1970s, conservation took on greater importance in the U.S. As a result, while the U.S. gross national product has increased by 70 percent since 1970, conservation and energy efficiency actually held total energy use to a comparatively low 24 percent increase. During this same period, however, electricity use grew by 80 percent.

Today, fully 36 percent of the primary energy consumed in the United States is used to generate electricity. By 2010, we expect that figure to grow as electricity consumption increases in parallel with projected economic growth. In addition, the necessity of meeting specific environmental goals often requires expanding the use of electricity as an alternative to other fuels.

The U.S. Government believes that increased conservation measures and demand-side management programs will reduce future generating capacity requirements. Recent Energy Information Administration projections indicate, however, that even after reducing demand through aggressive conservation measures, the U.S. will still need about 100-200 gigawatts of additional system capacity by 2010. By 2030, substantial additional new capacity will likely be needed.

The Administration has a policy for meeting this future demand for generating capacity. The first element in this policy is to give priority to aggressive energy efficiency and demand-side programs to reduce capacity requirements as much as possible. The second element is to develop renewable sources of electricity generation and use the abundant supply of natural gas that is available in the U.S. The Administration also supports nuclear power research and development to keep the nuclear power option open. Decisions on the use of individual technologies will rest with the private sector, however, and be based on local circumstances.

To keep the nuclear power option open, an unprecedented government and private industry partnership has been formed during the last five years to develop Advanced Light Water Reactors. This combined government/industry program is structured so that the eventual plant owners, primarily utilities, are managing the development programs in most cases. This ensures that the advanced plants being developed are attractive to the utilities that will own and operate them. The Administration is fully supporting this program.

Current U.S. nuclear power activities are focussed on four key areas. First, the U.S. department of Energy is cost-sharing and cooperating with industry to develop a new generation of Advanced Light Water reactors. Second, progress has been made through passage of the National Energy Policy Act of 1992 to eliminate overly restrictive regulatory barriers to nuclear power. Third, we are working to complete our evaluation of Yucca Mountain, Nevada, as a potential site for a geologic high-level waste repository. Finally, although we are deferring research and development of most long-range nuclear power technologies that have no near-term commercial applications, we are evaluating actinide recycle development because of its potential value to high-level waste management.

To improve efficiency, safety, and performance, the lessons of 30 years of experience with nuclear powerplants are being incorporated into design criteria for the next generation of U.S. plants. U.S., as well as some international, utilities have compiled these lessons into an extensive Advanced Light Water Reactor Utility Requirements Document.

The new Advanced Light Water Reactor (ALWR) plants will feature simpler designs, which will enable more cost-effective construction and maintenance. To enhance safety, design margins are being increased, and human factors are being considered and incorporated into the designs. Primary

emphasis is being placed on accident prevention, and emphasis is also increasing on accident mitigation.

In addition, the new ALWR designs will be standardized to make plant construction, operation, and maintenance simpler. And ALWR designs will utilize only proven technology, such that no demonstration plant will be needed. Finally, the designs will include features that reduce occupational radiation exposure and minimize radioactive and chemical releases to the environment.

As I mentioned earlier, the ALWR Program is part of a cooperative, cost-shared partnership among DOE, the utility industry, reactor manufacturers, equipment suppliers, and international participants. Significant progress has been made through this teamwork approach. The goal of the Advanced Light Water Reactor Program is to make standardized, certified (prelicensed) plant designs available for deployment during the 1990s.

The first major program thrust is to demonstrate new prelicensing, or certification, processes by achieving design certification for two large (1,250 to 1,350 MWe) Advanced Light Water Reactor plants under the new Nuclear regulatory Commission's combined-license regulations. These are General Electric's Advanced Boiling Water Reactor and Asea, Brown, Boveri-Combustion Engineering' System 80+ pressurized water reactor. These new designs feature major improvements over the current generation of light water reactors. They are simplified, improved, standardized designs, with enhanced safety and reliability and simplified operation.

The second major ALWR effort is devoted to developing and certifying a new type of light water reactor. These are two simplified, passive plants of intermediate size (600 MWe) --the Westinghouse AP600 Pressurized Water Reactor and the General Electric Simplified Boiling Water Reactor.

To achieve standardization, a First-of-a-Kind engineering program is being carried out to complete one or more of the advanced light water reactor designs so that firm cost and schedule estimates can be made and the design(s) can serve as a basis for a family of standardized plants.

Certification is a complex First-of-a-Kind undertaking. Many complex questions have been addressed and solved, such as the level of detail required for certified designs and the specification of acceptance tests to demonstrate conformance of a constructed plant with the certification.

As you can see, Final Design Approvals from the U.S. Nuclear regulatory Commission for the Advanced Boiling Water Reactor and the System 80 + are expected in 1994. Certification of these designs is anticipated for the 1995-1996 time frame.

The two 600-MWe designs feature passive safety systems and greatly simplified designs that enhance plant safety and reliability. The passive safety features incorporated in these designs allow accident mitigation without the need for operator action or external power sources. In addition, they offer the possibility of limiting emergency evacuation zones to the plant site boundaries.

The resulting simplicity, together with extensive use of prefabricated and modular materials, significantly reduces plant construction time and associated costs compared to previous designs. The smaller size and lower capital investment of these powerplants will offer utilities an additional option in providing safe, reliable electric power.

Safety Analysis Reports for passive designs were submitted to the U.S. Nuclear Regulatory Commission last year; review is under way. In addition, an extensive series of systems and component testing to demonstrate the passive safety features are being performed. Nuclear Regulatory Commission Final Design Approval of these simplified, passive designs is expected in 1996. Certification is anticipated for 1997.

The First-of-a-Kind Engineering program is focussed on achieving standardization by completing the design of one or more Advanced Light Water Reactors so that firm cost and schedule estimates can be made to provide the certainty needed by utilities to permit their ordering of new nuclear powerplants in the 1990s. This level of First-of-a-Kind engineering will be performed generically and be applied to all plants of the same design. The design can then serve as the basis for a family of standardized plant. This approximately \$ 270 Million program is cost-shared with private industry, with the private sector contributing more than half.

The First-of-a-Kind Engineering program is being managed by the Advanced Reactor

Corporation, a U.S. utility industry organization that was reorganized for this purpose. One evolutionary plant, the General Electric Company's advanced Boiling Water Reactor, and one passive plant, the Westinghouse AP600 Pressurized Water Reactor, have been selected for the initial program. Design-specific work for the First-of-a-Kind Engineering program began in 1993. The program is scheduled for completion in 1997.

Through its Nuclear Power Oversight Committee, the U.S. utility industry has developed a strategic plan to enable new plant orders during the 1990s. The Program I have described is a key part of this strategic plan. This chart depicts a possible schedule for new U.S. orders.

As shown, Nuclear Regulatory Commission design certification of the evolutionary and passive ALWRs will take place between 1995 and 1997. First-of-a-Kind Engineering activities will also be complete by 1997. Completion of these activities will make possible a new nuclear plant order during the 1990s. Construction of one or more new ALWRs can begin as early as 1997, and be complete by the early 2000s, at which point operation can begin. After initial operation of these first new plant(s), and with marketplace support, new follow-on orders can be placed, and construction of a new generation of nuclear powerplants can begin, with operation starting by or before 2010.

Of course, no discussion of new nuclear powerplant designs would be complete without a brief look at the economics involved with these designs.

A number of U.S. economic studies have concluded that, by the turn of the century, these four passive and evolutionary plant designs under development as part of the Advanced Light Water Reactor Program will be competitive with alternative sources of base-load generation. A number of areas are being addressed to ensure this level of competitiveness is achieved.

This chart shows six steps toward meeting the cost targets for U.S. Advanced Light Water reactors. As we have discussed, the use of simplified, standardized designs enhances plant safety and reliability. But using fewer, less complicated, standardized components and systems also lowers total plant cost by lessening the cost of construction, operation, and maintenance.

Completing design activities and obtaining design certification by the U.S. Nuclear Regulatory Commission prior to start of construction avoids the risk of rework during construction and allows greater construction planning. Obtaining certification also allows a reduction in schedule risk, which avoids potential large cost increases due to interest payments.

Shorter construction times obviously lower costs. We expect construction of an Advanced Light Water Reactor to be completed in three to five years. This reduction in construction time is a result of simplifying and modularizing plant designs to make them more complete prior to startup of construction.

As for improved work force productivity, the U.S. nuclear industry is embarking on a major new initiative to reduce production costs, including operations and maintenance. The primary focus of this initiative is the improvement of work force productivity to make nuclear power more competitive with other energy sources. This initiative is scheduled for formal public release in November.

Meeting the economic goals of the Advanced Light Water Reactor Program is also dependent on supporting progress in licensing and waste management.

The National Energy Policy Act of 1992, passed in October of last year, provided multi-year authorization for DOE's Advanced Light Water Reactor (ALWR) design certification and First-of-a-Kind engineering programs to support commercialization of ALWR reactor designs during the 1990s.

This legislation was passed with strong bipartisan support in the U.S. Congress. The Act endorses nuclear power as an important option for future electricity generation and codifies the Nuclear Regulatory Commission's Part 52 licensing reform rule, which provides for certification of standardized designs, one-step licensing, and more efficient hearing on new nuclear plant construction.

To ensure a more predictable licensing process, the Act specifically provides for:

- Combined construction and operating licenses;
- A focused scope for post-construction hearings;

- Plant operation during hearings (if safety is not at issue); and
- A limited scope of hearings to amend combined licenses.

This chart shows how the provisions of the Energy Policy Act have improved the nuclear powerplant licensing process in the U.S. After the Nuclear Regulatory Commission has certified a plant design and pre-approved a plant site through the Early Site Permit process, a Safety Analysis Review is performed on the safety of both the design and its intended site. If the results of this review are favorable, a Safety Analysis Report is issued and a combined construction and operating license can be obtained. Only after this combined license is received does construction actually begin. The combination of the construction and operating licenses ensures future operation, and therefore, recovery of construction costs, for utilities.

The new licensing procedures also enhance the effectiveness of public participation in the Nuclear Regulatory Commission licensing process by ensuring early public involvement in utility planning. Hearings and decisions concerning plant design safety, site approval, and emergency evacuation can now be resolved before construction begins. In addition, the public may request a hearing on any nonconformances of the constructed plant to the approved design.

In addition to its goals pertaining to nuclear power, the current Administration is also placing a high priority on continuing our efforts to solve the problem of high-level waste management disposal. We in the United States are continuing our commitment to the eventual geologic disposal of spent nuclear reactor fuel and other high-level radioactive waste. Exploratory drilling at the Yucca Mountain site in the State of Nevada is progressing. Secretary of Energy O'Leary announced recently that the U.S. Radioactive Waste Management Program would be refocused, putting "increased emphasis on the highest quality scientific work and the inclusion of external parties in program development and implementation. "The Secretary also plans to initiate new activities and policies, including creating the position of a Chief Scientist for the Yucca Mountain Project organization; initiating negotiations with local governments of appropriate Payments equal to Taxes; and developing a program to increase the involvement of the Nevada university System in Yucca Mountain site characterization activities.

In addition, the Secretary is reconsidering other areas of the program, such as an approach for the 1998 waste acceptance requirement, including utility compensation alternatives; a full range of options for the near-term storage of spent fuel pending ultimate disposal; and alternative repository licensing strategies.

Another U.S. nuclear research and development effort that is worthy of mention is the Department of Energy's Actinide Recycle Program. Although the Department of Energy is closing out its design work on the advanced liquid metal reactor, work is continuing on the actinide recycling concept. This technology demonstration program will evaluate the technical and economic feasibility of an innovative, more diversion-resistant nuclear fuel cycle technology which could potentially contribute to the long-term radioactive waste management system. The technology offers the potential to expand the usable capacity of a nuclear waste repository and to safely and economically use the most long-lived portions of nuclear waste as fuel for other advanced reactors.

Currently, engineering-scale testing of actinide recycle technology is scheduled for this year. The Administration fully supports the Actinide Recycle Program, which is scheduled for completion by 1997, at which time sufficient information should be available to allow a private industry decision on whether to proceed with commercialization of this technology.

In summary, progress is being made toward development and deployment of new nuclear powerplants in the U.S. The Energy Policy Act of 1992 demonstrated Congressional support for nuclear power development and greatly improved the licensing process for new nuclear plant construction. Safe, efficient nuclear powerplant operations are continuing. Reactor improvements are being made and standardized designs are being developed that have a greater degree of plant safety and reliability, as well as better economics.

In addition, progress toward construction of a permanent high-level radioactive waste repository is being made, and work to evaluate the technical and economic feasibility of actinide recycling is under way.

All U.S. nuclear power research and development programs are directed toward removing impediments to the growth of nuclear energy in the U.S., and we are optimistic that our investment in

this technology will serve us well. Nuclear energy in the United States has faced a host of challenges and, while some challenges remain to be addressed, the technology is well positioned for a new era of competition. U.S. nuclear utilities, through the Nuclear Power Oversight Committee, have developed a strategic plan to enable the order of new nuclear plants during the 1990s. The significant management talent, as well as financial resources, devoted by these utilities is evidence of the seriousness of their intent. The partnership between the U.S. Government and private industry will make improved, precertified nuclear plants a real option in the U.S. and overseas in this decade. I have confidence that our new plant designs demonstrate technological leadership and will be highly-competitive products in the emerging marketplace.

In closing, I want to say that I believe the energy strength and security of the United States, and of all countries, lies in diversity. The advantages that such diversity offers are too great to be ignored.

Again, I'd like to thank you, the audience, and our hosts for the opportunity to be here today.